

# POLLUTION PREVENTION

## ALTERNATIVES TO CHLORINATED SOLVENTS



# Solvent Substitution Options

*Ecology Fact Sheet*

*Publication Number 96-420*

Chlorinated solvents are popular for cleaning and degreasing because they can dissolve soils, are non-flammable, and are compatible with many types of material. However, their toxicity and adverse environmental effects have resulted in tighter regulations controlling their use and manufacture. The search for less toxic solvents has led to the development of cleaning systems that can save you money. It is estimated that 80 — 90 percent of chlorinated parts cleaning solvents are replaceable.

## Make the Switch!

- When considering alternatives to chlorinated solvents, you may be able to save money by evaluating your need to clean, as well as investigating new cleaning systems or products.
- Involve the people who will be working with the new product or system in the study and sample testing.

## Minimize the Need to Clean

***Study the in-house processes (and handling) which may unnecessarily soil the part.*** Are “good housekeeping” practices in place? Can altering a process avoid cleaning later? Consider the necessity of all the materials which are being used on the part that later require cleaning. Substitute materials which do not require further (or extensive) cleaning in a later process. For example, water-soluble cutting oils are more easily removed from parts.

***How clean is clean?***... What level of cleanliness is required by the next process the part goes through? How clean do your customers need the parts? Can you eliminate some cleaning and still meet the needs (quality and usefulness) of your product?

***Evaluate the products/parts you receive from outside suppliers.*** Can your supplier change a process, transportation method, or housekeeping practice to decrease your cleaning efforts?

CLEANING METHOD	DESCRIPTION	SUBSTRATES	
ABRASIVE	<ul style="list-style-type: none"> <li>■ Compressed air, water pressure, or steam</li> <li>■ Sand, steel grit, sodium bicarbonate, aluminum oxide, organic materials, plastic media, CO2 pellets and wheat chaff</li> <li>■ Mechanical impact</li> <li>■ Buffing or brushing</li> </ul>	<ul style="list-style-type: none"> <li>■ All types</li> <li>■ Caution must be used with thin materials</li> </ul>	<ul style="list-style-type: none"> <li>■</li> <li>■</li> <li>■</li> <li>■</li> </ul>
AQUEOUS	<ul style="list-style-type: none"> <li>■ Alkaline, neutral or acidic cleaners</li> <li>■ Alkaline or acidic builders, additives may be used such as water softeners, rust or corrosion inhibitors, stabilizers, chelating agent, surfactants and some solvents</li> <li>■ Emulsification and/or suspension of soils by immersion or spraying</li> <li>■ Enhanced through heating, agitation, or ultrasound</li> </ul>	<ul style="list-style-type: none"> <li>■ All types</li> <li>■ Alkaline cleaners have high pH which may cause etching on magnesium</li> <li>■ Acids not suitable for some stainless steels and magnesium</li> </ul>	<ul style="list-style-type: none"> <li>■</li> <li>■</li> <li>■</li> </ul>
SEMI-AQUEOUS	<ul style="list-style-type: none"> <li>■ Water with various solvents, surfactants and additives, with a water rinse</li> <li>■ Substitute solvent: Terpenes, petroleum, hydrocarbons, glycol ethers, vegetable oils, fatty acids, and esters</li> <li>■ Cleaning in both sprays and immersion tanks</li> </ul>	<ul style="list-style-type: none"> <li>■ All types</li> <li>■ Neutral pH of cleaners prevents etching and reduces metals in waste stream</li> </ul>	<ul style="list-style-type: none"> <li>■</li> <li>■</li> <li>■</li> <li>■</li> </ul>
ALCOHOLS	<ul style="list-style-type: none"> <li>■ Aliphatic and aromatic hydrocarbon mixtures highly soluble in water</li> <li>■ Used semi-aqueously to reduce flammability</li> <li>■ Low molecular weight: methanol, ethanol, and propanol</li> <li>■ Medium molecular weight: tertbutanol, and 2-pentanol</li> </ul>	<ul style="list-style-type: none"> <li>■ All types</li> <li>■ May be slightly corrosive to some metals</li> </ul>	<ul style="list-style-type: none"> <li>■</li> <li>■</li> <li>■</li> <li>■</li> </ul>
ALIPHATIC HYDROCARBONS AND KETONES	<ul style="list-style-type: none"> <li>■ Organic solvents used extensively in cleaning</li> <li>■ Naphtha, mineral spirits, stoddard solvent, toluene, xylene, hexane, methyl ethyl ketone, acetone and others</li> <li>■ Immersion tanks</li> <li>■ Spray cleaning</li> <li>■ Heated to enhance cleaning</li> <li>■ Air or forced air dried</li> </ul>	<ul style="list-style-type: none"> <li>■ All types</li> <li>■ Non-corrosive with most metals</li> <li>■ Caution - use on some plastics and rubber</li> </ul>	<ul style="list-style-type: none"> <li>■</li> <li>■</li> <li>■</li> <li>■</li> </ul>
DRY HEAT	<ul style="list-style-type: none"> <li>■ Baking ovens reduce soil to a powder</li> <li>■ May include peening or abrasive step to remove powdered soil</li> </ul>	<ul style="list-style-type: none"> <li>■ Parts must not be heat-sensitive</li> </ul>	<ul style="list-style-type: none"> <li>■</li> <li>■</li> </ul>
DI-BASIC ESTERS (DBE)	<ul style="list-style-type: none"> <li>■ A mixture of methyl esters</li> <li>■ Used at 100% strength or mixed with other solvents</li> </ul>		<ul style="list-style-type: none"> <li>■</li> <li>■</li> </ul>
GLYCOL ETHERS (“CELLOSOLVE”)	<ul style="list-style-type: none"> <li>■ Ethylene glycol monobutyl ether, ethylene glycol monoethyl ether, ethylene glycol monobutyl ether, acetate</li> <li>■ May be a component found in custom cleaners</li> </ul>		<ul style="list-style-type: none"> <li>■</li> <li>■</li> </ul>
N-METHYL PYRROLIDONE (NMP)	<ul style="list-style-type: none"> <li>■ May be blended with surfactants and thickeners</li> <li>■ May be used in ultrasonic systems</li> </ul>	<ul style="list-style-type: none"> <li>■ Some plastics are soluble in NMP</li> <li>■ NOT recommended for brass or bronze</li> </ul>	<ul style="list-style-type: none"> <li>■</li> </ul>
TERPENES	<ul style="list-style-type: none"> <li>■ Distilled from plant material such as citrus peels</li> </ul>	<ul style="list-style-type: none"> <li>■ May affect elastomers</li> <li>■ Are non-corrosive</li> <li>■ Do not stain or etch</li> <li>■ Not aggressive toward metals, most plastics and polymers</li> </ul>	<ul style="list-style-type: none"> <li>■</li> <li>■</li> <li>■</li> </ul>

WASTE MANAGEMENT	RECYCLING PROCESSES	ADVANTAGES	DISADVANTAGES
<p>Filtration of media</p> <p>Wet methods generally require treatment (prior to discharge)</p> <p>Protective equipment for airborne dust control</p> <p>Effluent control for wet processes</p> <p>Spent media must be tested to determine toxicity</p>	<ul style="list-style-type: none"> <li>Recirculation equipment decreases costs by reusing media several times</li> </ul>	<ul style="list-style-type: none"> <li>Eliminate the use of hazardous chemicals</li> <li>Wheat chaff works well on intricate parts</li> <li>Can strip paint</li> </ul>	<ul style="list-style-type: none"> <li>May be manually intensive, and time consuming</li> <li>May affect corrosion-resistance of some metals</li> </ul>
<p>Contaminants removed from parts dictate treatment required</p> <p>May require oil skimmed or separated, metals removed, and pH neutralized</p> <p>Cleaners and effluent from cleaning operation must be tested to determine toxicity</p>	<ul style="list-style-type: none"> <li>Gravity separation, oil skimmed or separated</li> <li>Reuse possible with filtration</li> <li>Demulsifiers sometimes required to separate oils</li> </ul>	<ul style="list-style-type: none"> <li>Equipment and cleaners can be tailored to your specific soils</li> <li>Significant reduction in hazardous substances used</li> <li>No VOCs released</li> </ul>	<ul style="list-style-type: none"> <li>May increase water, energy usage, and floor space needed</li> <li>May leave a residue and require water treatment</li> <li>Rinsing and drying are sometimes required</li> </ul>
<p>Contaminates removed from parts dictate treatment required</p> <p>May require oil skimmed or separated, metals removed and/or pH neutralized</p> <p>Large potential waste stream if not recycled</p> <p>Emissions may be regulated</p>	<ul style="list-style-type: none"> <li>Gravity separation, oil skimmed or separated</li> <li>Reuse possible with filtration</li> <li>Demulsifiers sometimes required to separate oils</li> </ul>	<ul style="list-style-type: none"> <li>Equipment and cleaners can be tailored to your specific soils</li> <li>Effective for heavily soiled parts</li> </ul>	<ul style="list-style-type: none"> <li>Difficult to recycle by distillation</li> <li>Rinsing and drying stage sometimes required</li> <li>May be combustible or flammable</li> </ul>
<p>Oil skimmed or separated</p> <p>Pretreatment includes carbon adsorption, reverse osmosis, or biological treatment possible</p> <p>Incineration sometimes required</p> <p>Aquatic toxicity low for aliphatic and high for aromatic hydrocarbon</p> <p>Emissions may be regulated</p>	<ul style="list-style-type: none"> <li>Carbon adsorption with steam stripping solvent recovery</li> <li>May be complicated by azeotropic mixture</li> </ul>	<ul style="list-style-type: none"> <li>Does not leave residue</li> <li>Equipment and many case studies available</li> <li>Alcohol in final rinse improves wettability and controls spotting</li> </ul>	<ul style="list-style-type: none"> <li>Incineration sometimes only acceptable disposal method</li> <li>Cleaning, rinsing and drying stage</li> <li>Some may be flammable</li> </ul>
<p>Still bottoms generally designated as dangerous waste</p> <p>Incineration sometimes required</p> <p>Aquatic toxicity low for aliphatic and high for aromatic hydrocarbons</p> <p>Emissions may be regulated</p>	<ul style="list-style-type: none"> <li>Filtration will prolong life but does not generally remove oil</li> <li>Distillation; vacuum assist may be required</li> </ul>	<ul style="list-style-type: none"> <li>Commonly used for metal parts cleaning</li> <li>Equipment and solvent are widely available</li> <li>Can remove grease, tar, waxes, paint and hard to remove soils</li> </ul>	<ul style="list-style-type: none"> <li>Some may be flammable</li> <li>May leave oily residue</li> <li>May be toxic or create an extremely hazardous waste</li> </ul>
<p>Powdered soils may designate</p> <p>Combustion gases may require permitting in some areas</p>	<ul style="list-style-type: none"> <li>If abrasive material used, it may be recyclable</li> </ul>	<ul style="list-style-type: none"> <li>Does not use hazardous chemicals</li> </ul>	<ul style="list-style-type: none"> <li>Consumes energy</li> </ul>
<p>VOC emissions may be regulated, but vapor pressure is low</p> <p>Maybe toxic dangerous waste</p>	<ul style="list-style-type: none"> <li>May be recycled using vacuum still</li> </ul>	<ul style="list-style-type: none"> <li>Is considered biodegradable</li> <li>Can strip paint</li> </ul>	<ul style="list-style-type: none"> <li>Has stringent work exposure limits</li> <li>Is a VOC, but emissions are low</li> </ul>
<p>VOC emissions may be regulated</p> <p>May be ignitable or toxic hazardous waste</p>		<ul style="list-style-type: none"> <li>Emulsifies well</li> </ul>	<ul style="list-style-type: none"> <li>Are VOC's and flammable</li> <li>Low worker exposure limit, implicated as a cause for birth miscarriages in workers</li> </ul>
<p>Contaminants removed from parts dictate disposal</p>	<ul style="list-style-type: none"> <li>Many oils can be separated from the solvent when temperature is lowered</li> <li>Can be distilled</li> </ul>	<ul style="list-style-type: none"> <li>Can be rinsed with water</li> <li>Excellent removal of organic coatings</li> </ul>	<ul style="list-style-type: none"> <li>Is combustible</li> </ul>
<p>Considered biodegradable</p> <p>May be ignitable or toxic hazardous waste</p> <p>Contaminants may necessitate hazardous waste disposal</p>	<ul style="list-style-type: none"> <li>Filtration will prolong life</li> </ul>	<ul style="list-style-type: none"> <li>Considered biodegradable</li> <li>Can clean heavy grease and residues</li> </ul>	<ul style="list-style-type: none"> <li>May have a strong odor</li> <li>Can cause chemical sensitivity in workers</li> <li>May be flammable</li> </ul>

# Cleaning Alternatives

**Identify possible alternatives.** Find the process or product that uses the least hazardous substance or generates the least amount of hazardous waste and achieves the desired results. (See the alternative table inside this guide, p.2.) It's best to find alternatives which have been used in a similar application.

**Evaluate the effect of each alternative on the substrate (part).** When identifying alternative products or processes, it is important to "field test" them in your facility. Your substrate may react to specific cleaners.

**Waste generation and disposal.** Recyclability of the cleaning solution is an important consideration for both economic and environmental reasons. Recycling may reduce the need for disposal of hazardous waste.

**Perform a cost analysis.** Compare the total cost of current and alternative practices. Contact your nearest regional Ecology office for a guide "Economic Analysis for Pollution Prevention".

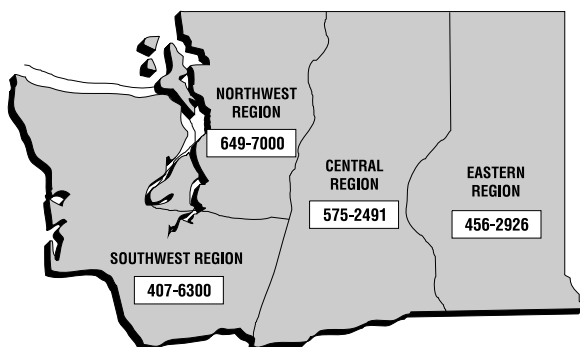
**Equipment selection.** New equipment may improve cleaning capabilities, including equipment designed for specific parts, spraying mechanisms and ultrasonics.

**Track your efforts.** Track your efforts on each alternative cleaning method or product to allow for a direct comparison.

For more detailed information on solvent substitution and alternative cleaning systems, ask for the following Ecology publications:

Waste Reduction For Small Parts Washers  
Evaluation of Solvent Substitutes  
Optimizing Your Parts Cleaning System  
Switching to Aqueous Parts Cleaning  
Solvent Substitution: Where to Find Information

publication # 96-421  
publication # 96-424  
publication # 96-423  
publication # 96-425  
publication # 96-421



The Department of Ecology is an equal opportunity agency and does not discriminate on the basis of race, creed, color, disability, age, religion, national origin, sex, marital status, disabled veteran's status, Vietnam Era veteran's status or sexual orientation.

If you have special accommodation needs or require this document in alternative format, please contact the Hazardous Waste and Toxics Reduction Program at (360) 407-6700 (voice) or (360) 407-6006 (TDD).

Ecology's telecommunications device for the deaf (TDD) number is (360) 407-6006. Regional TDD numbers are:

CRO (TDD) (509) 454-7673  
ERO (TDD) (509) 458-2055

NWRO (TDD) (206) 649-4259  
SWRO (TDD) (360) 407-6306